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NOZZLE SELECTION FOR SELF PROPELLED SPRAYERS

Selecting the best nozzles for a sprayer involves a number of factors including droplet size requirements, deposit uniformity, required output, and durability. These factors are further complicated by the effects of pressure, height and spacing on deposit uniformity; and the effect of pressure on droplet size.

Some post emergence herbicides require very small droplet sizes - in the range of 200 µm. Others will tolerate somewhat larger sizes. Larger droplets will produce less complete coverage, and they may burn holes in the leaves of weeds without killing them, or roll off the leaves and be wasted. In the case of ground applied chemicals, droplet size is not critcal. All hydraulic nozzles produce a wide range of droplet sizes from very small to quite large. The "average" size produced (commonly called the median volume diameter or VMD) depends on the size and type of orifice and on the pressure applied. Higher pressures and smaller orifices produce smaller droplets. The danger of spray drift increases rapidly with decreasing droplet size, and any droplets less than 100 µm in diameter are very prone to drifting. The VMD and % of spray volume under 100 µm for various nozzles are shown in Table 1.

The spray deposit uniformity varies a great deal with nozzle type, pressure spacing and height. The amount of variation in the spray deposit is expressed as the coefficient of variation (C of V or CV). A perfectly uniform pattern would have a CV of 0. The less uniform a spray deposit is, the higher the CV. The acceptable maximum CV depends on the product being applied. Some herbicides require a very narrow range of application rates for best results, while others tolerate a much wider range. Maximum CV's may range from 10 to 20% with various herbicides, and fertilizers may even find CV's above 20% acceptable.

In any chemical application, the lowest possible CV is desirable, in order to reduce product waste and crop damage, and to obtain the best chemical effectiveness.

The spray deposit uniformity for various nozzles and conditions are given in Table 2.

TABLE 1

SPRAY DROPLET SIZES

(taken from manufacturer's literature)

NOZZLE	PRESSURE	MEDIAN VOLUME DIAMETER (VMD) MICROMETRES (μm)	% OF VOLUME UNDER 100 μm
Flooding	275 kPa		
K5		575	0.1
K10		730	0.05
K20		915	0.02
K30		1050	less than 0.01
K40		1180	less than 0.01
K50		1320	less than 0.01
Raindrop	275 kPa		
RD1		310	1.0
RD2		410	0.8
RD3		460	0.8
RD4		540	0.7
RD5		655	0.6
RD6		740	0.5
RD7		865	0.4
RD8		1050	0.35
Flat Fan	275 kPa		
8004		430	0.01
8006		495	less than 0.01
8010		610	less than 0.01
8020		940	less than 0.01
8030		1170	less than 0.01
LP Flat Fan	100 kPa		
8002LP		470	0.02
8003LP		540	0.01
8004LP		600	less than 0.01
8005LP		640	less than 0.01
8006LP		700	less than 0.01
8008LP		780	less than 0.01
8010LP		960	less than 0.01

TABLE 2

SPRAY DEPOSIT UNIFORMITY

NOZZLE	HEIGHT m	SPACING m	PRESSURE kPa	C. of V.
8002LP	1.0	0.5	175	9 - 14
	0.4	0.5	150 - 300	5 - 10
8004LP	1.0	0.5	275	14 - 17
	0.4	0.5	150 - 300	12 - 14
	1.0	1.0	275	7 - 16
8006LP	0.5	0.5	240	8 - 13
11003LP	0.4	0.75	100 - 300	9 - 11
	0.7	0.75	100 - 300	7 - 11
8004	1.0	1.0	275	12 - 14
	0.5	0.5	200 - 300	5 - 7
LF5-80^{o}	0.5	0.5	200 - 300	4 - 7
8008	1.0	1.0	275	9 - 11
11003	0.4	0.75	200 - 300	11 - 12
	0.7	0.75	200 - 300	12 - 14
TK 2.5	1.0	1.0	275	28 - 35
	1.0	0.5	275	33 - 34
TK 5.0	1.0	1.0	275	22 - 30
	1.0	1.5	275	30 - 34
TK 10	1.0	1.0	275	25 - 43
	1.0	1.5	275	24 - 32
TK 15	1.3	1.5	200	23 - 32

FLAT SPRAY TIPS

Both the standard pressure and extended range flat spray tips normally produce more uniform patterns than do Floodjet or Raindrop nozzles. This is very important when applying herbicides.

The extended range tips (LP, LFR and XR designations) can be operated at pressures from 100 kPa to 300 kPa with much less variation in spray pattern than other nozzle types. Recommended nozzle spacings are 50 cm although spacings up to 1.0 m may also produce good patterns with an appropriate nozzle height. A nozzle height of 80 to 100% of the nozzle spacing produces a good pattern with the 80^{o} extended range tips. The 110^{o} extended range tips also have a recommended nozzle spacing of 50 cm although spacings up to 1.0 may be used. Recommended minimum nozzle heights are 50% of the nozzle spacing. Heights up to one metre also produce good patterns.

The standard 80° flat spray nozzles should be operated at pressures of 200 to 300 kPa. Recommended nozzle heights are 90 to 100% of the nozzle spacings with a maximum of one metre.

FLOODING SPRAY TIPS

Flooding nozzles produce widely varying patterns depending on nozzle size, pressure and material sprayed. Because of these variations it is very difficult to recommend "best" pressures, spacings or heights. Pressures below 150 kPa usually produce very heavy streaks at the edges, so these should be avoided. Pressures between 200 and 275 kPa usually produce the best patterns. Nozzle spacings with flooding nozzles should not exceed 1.5 m. Where uniformity of deposition is critical, flooding nozzles should not be used.

To replace flooding nozzles with standard or LP flat spray tips refer to the following chart. This chart assumes that the same pressures and application volumes are desired.

FLOODING NOZZLES	at	SPACING	FLAT SPRAY NOZZLES	at	SPACING
K10	"	1.0 m	8006LP or 11006LP	"	0.5 m
K10	"	1.5 m	8006LP or 11006LP	"	0.75 m
K15	"	1.5 m	8006LP or 11006LP	"	0.5 m
K20	"	1.5 m	8008LP or 11008LP	"	0.5 m
K10	"	1.0 m	8010	"	0.5 m
K15	"	1.0 m	8015	"	0.5 m
K15	"	1.5 m	8010	"	0.5 m
K20	"	1.0 m	8020	"	0.5 m
K30	"	1.0 m	8030	"	0.5 m
K30	"	1.5 m	8020	"	0.5 m
K40	"	1.0 m	8040	"	0.5 m
K50	"	1.0 m	8050	"	0.5 m
K60	"	1.0 m	8060	"	0.5 m
K60	"	1.5 m	8040	"	0.5 m

To replace flooding nozzles with extended range tips, use the same nozzle number but reduce the spacing in half. e.g. K5 or D5 flood nozzles at 1.5 m would be replaced by XR11005 or LFR5 extended range tips at 75 cm spacings.

RAINDROP NOZZLES

Raindrop nozzles must be operated at 45 to 90° from vertical in order to produce a reasonably acceptable pattern. Even at these angles the CV may be very high depending on the pressure and spacing used. A minimum pressure of 200 kPa is recommended along with a nozzle spacing of 0.5 m. A somewhat wider spacing may be acceptable for the wide angle (RA) type. The spray drift hazard is increased as the nozzle is tilted further from the vertical. Extra precautions must therefore be taken to prevent damage to surrounding areas when nozzles are set to direct the spray horizontally or near to horizontal.

RECOMMENDATIONS FOR POST EMERGENCE APPLICATION

BOOM MOUNTING

Do not use a boom mounted ahead of the sprayer wheels. Very poor weed control is usually obtained in the wheel tracks when a front mounted boom is used. Mount the boom behind the wheels, and if possible mount it back far enough to avoid the turbulent area right behind the wheels.

FORWARD SPEED

Several herbicide manufacturers specify a forward speed of 20 km/h or less for best results. Check the label for any speed restrictions.

WATER VOLUMES

Minimum and/or maximum water volumes are specified by most herbicide manufacturers. Check the label to find the recommended water volume for each chemical.

WIND SPEED

Do not spray in winds above 20 km/h. Higher winds increase the amount of spray drift produced.

NOZZLE HEIGHTS, SPACINGS AND PRESSURES

Use nozzle heights of one metre or less. Higher nozzle heights increase the amount of spray drift produced.

NOZZLE TYPE	RECOMMENDED PRESSURE	RECOMMENDED SPACING	RECOMMENDED HEIGHT
Standard 80° flat spray tip	200 - 300 kPa	50 - 100 cm	90 - 100% of nozzle spacing
Standard 110° flat spray tip	200 - 300 kPa	50 - 100 cm	50 - 90% of nozzle spacing
Extended range flat spray tips	150 - 300 kPa	50 - 100 cm (80°)	80 - 90% of nozzle spacing
		(110°)	50 - 90% of nozzle spacing

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CHECKING FOR NOZZLE WEAR

1. Any nozzle that has an output of more than 15% above its original output should be discarded.

   Example: Original nozzle output at 250 kPa is 2.2 L/min.

   1.15 x 2.2 = 2.53

   Nozzles with outputs above 2.53 L/min should be discarded.

2. Nozzles that vary more than ±5% from the average output should be discarded.

   Example: A sprayer has nozzles with the following outputs:

1.	2.16	6.	2.31
2.	2.50	7.	2.46
3.	2.34	8.	2.29
4.	2.42	9.	2.37
5.	2.20	10.	2.35

   Average output is 2.34 L/min

   1.05 x 2.34 = 2.46
   0.95 x 2.34 = 2.22 } allowable range

   Discard nozzles 1, 2 and 5 because they are outside of the allowable range.

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BASIC RULES AND QUESTIONS FOR METRIC PESTICIDE APPLICATION

RULE #1

Convert all field sizes to hectares.

RULE #2

Convert all spray tank capacities to litres.

WHEN THESE TWO CONVERSIONS ARE COMPLETED, ASK TWO QUESTIONS:

QUESTION #1

How many hectares will one tank load cover?

QUESTION #2

How much chemical is needed for each tank load?

$$\text{hectares per hour} = \frac{\text{swath width (m)} \times \text{speed (km/h)}}{10}$$

$$\text{hectares covered} = \frac{\text{swath width (m)} \times \text{distance travelled (m)}}{10{,}000}$$

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Converting Acres to Hectares

To obtain conversion to hectares, find acre range and go across to the exact acreage required.

Example 1 - 49.0 Acres. Go down to 40 - 49 range and across to 9. Answer is 19.6 hectares.

For values over 100 acres, add 40 for each 100 A and use table for remaining acres.

Example 2 - 149.0 Acres - 40 ha plus 19.6 ha. Answer is 59.6 ha.

Acre Range	0	1	2	3	4	5	6	7	8	9
0 - 9	0	0.4	0.8	1.2	1.6	2.0	2.4	2.8	3.2	3.6
10 - 19	4.0	4.4	4.8	5.2	5.6	6.0	6.4	6.8	7.2	7.6
20 - 29	8.0	8.4	8.8	9.2	9.6	10.0	10.4	10.8	11.2	11.6
30 - 39	12.0	12.4	12.8	13.2	13.6	14.0	14.4	14.8	15.2	15.6
40 - 49	16.0	16.4	16.8	17.2	17.6	18.0	18.4	18.8	19.2	19.6
50 - 59	20.0	20.4	20.8	21.2	21.6	22.0	22.4	22.8	23.2	23.6
60 - 69	24.0	24.4	24.8	25.2	25.6	26.0	26.4	26.8	27.2	27.6
70 - 79	28.0	28.4	28.8	29.2	29.6	30.0	30.4	30.8	31.2	31.6
80 - 89	32.0	32.4	32.8	33.2	33.6	34.0	34.4	34.8	35.2	35.6
90 - 99	36.0	36.4	36.8	37.2	37.6	38.0	38.4	38.8	39.2	39.6

1 acre = 0.4 hectare 1 hectare = 2.5 acres

1 ha = 10 000 m^2

A = acre ha = hectare m = metre

NOTE: Conversions assume acre figures were accurate to one decimal place. In most field situations acreage figures are not this accurate. Therefore, hectare figures can be rounded to the nearest whole number in most field situations. Example 49 A can be rounded to 20 ha, 149 A can be rounded to 60 ha.

METRIC UNITS FOR GROUND APPLICATORS

TANK CAPACITIES

Can. gal.	litres (L)	U.S. gal.	litres (L)
100	450	100	375
200	900	200	750
300	1400	300	1150
400	1800	400	1500
500	2300	500	1900
600	2700	600	2300
800	3600	800	3000
1000	4500	1000	3800
1200	5400	1200	4500
1500	6800	1500	5700
2000	9100	2000	7600

BOOM WIDTHS

feet	metres (m)
40	12
45	13.5
50	15
55	16.5
60	18
70	21
80	24
100	30

NOZZLE SPACINGS

inches	millimetres (mm)	metres (m)
20	500	0.5
30	750	0.75
40	1000	1.0
60	1500	1.5
80	2000	2.0
120	3000	3.0

PRESSURES

pounds per square inch (psi)	kilopascals (kPa)
10	70
15	100
20	150
25	175
30	200
35	250
40	275
45	300
50	350

AREA

acres	hectares (ha)
1	0.4
2.5	1
5	2
10	4
15	6
20	8
25	10
30	12
40	16
50	20
60	24
75	30
100	40
125	50
150	60

APPLICATION VOLUMES

Can. gal. per acre	litres per hectare (L/ha)
4	45
4.5	50
5	55
7	80
9	100
10	110
12	135
15	170
18	200
20	220
25	275
30	330
35	385
40	440
50	550

DISTANCES

1 rod = 5 metres (m)
1/8 mile = 200 metres (m)
1/4 mile = 400 metres (m)
1/2 mile = 800 metres (m)
1 mile = 1600 metres (m)

SPEED

miles per hour	kilometres per hour (km/h)
5	8
8	13
10	16
12	18
15	24
18	29
20	32

AREA CALCULATION

1 hectare (ha) = 10,000 square metres (m^2)

$$\text{Area covered (ha)} = \frac{\text{width in metres} \times \text{length in metres}}{10{,}000}$$

Example: Field 400 m x 800 m = $\frac{400 \times 800}{10{,}000}$ = 32 ha

APPLICATION VOLUME CALCULATION

$$\text{L/ha} = \frac{\text{litres used}}{\text{area covered}}$$

Example: 3000 litres used to cover 30 hectares

Application Volume = $\frac{3000}{30}$ = 100 L/ha

RATE OF WORK CALCULATION

$$\text{Work rate in hectares per hour (ha/h)} = \frac{\text{width in metres} \times \text{speed in km/h}}{10}$$

Example: Sprayer width 18 metres, forward speed 24 km/h

Work rate = $\frac{18 \times 24}{10}$ = 45 ha/h

METRIC UNITS FOR GRANULAR APPLICATORS

MACHINE WIDTHS

feet	metres (m)
12	3.7
16	4.9
20	6.1
24	7.3
28	8.5
32	9.8
36	11.0
40	12.2
45	13.7
48	14.6
54	16.5
60	18.3

VOLUME CAPACITIES

cubic feet	cubic metres (m^3)
1	0.03
5	0.14
10	0.28
15	0.42
20	0.57
25	0.71
30	0.85
35	0.99
40	1.13
45	1.27
50	1.42
100	2.83

DISTANCES

	metres (m)
1 rod	5
1/8 mile	200
1/4 mile	400
1/2 mile	800
1 mile	1600

AREAS

acres	hectares (ha)
1	0.4
2.5	1
5	2
10	4
15	6
20	8
25	10
30	12
40	16
50	20
60	24
70	28
75	30
80	32
90	36
100	40
125	50
150	60

APPLICATION RATES

lbs/acre	kilograms per hectare (kg/ha)
0.9	1.0
1.0	1.1
1.25	1.5
1.5	1.75
1.75	2.0
2.0	2.25
2.7	3.0
3.0	3.25
4.0	4.5
4.5	5.0
5.0	5.5
6.0	6.75
9.0	10.0
10.0	11.0
15.0	16.5
20.0	22.0
25.0	27.5
30.0	33.0
40.0	44.0

WEIGHTS

pounds	kilograms (kg)
1	0.45
2	0.9
2.2	1.0
4.4	2.0
5	2.3
8.8	4.0
10	4.5
20	9.1
22	10.0
25	11.3
44	20.0
50	22.7
55	25.0
100	45.4

SPEEDS

miles per hour	kilometres per hour (km/h)
4	6.5
5	8
6	9.5
7.5	12
10	16
12	19
15	24
20	32

AREA CALCULATION

1 hectare = 10,000 m^2

$$\text{Area covered (ha)} = \frac{\text{width in metres x length in metres}}{10{,}000}$$

Example: Field measuring 1/8 mile by 1/2 mile (200 m x 800 m)

$$= \frac{200 \times 800}{10{,}000} = 16 \text{ ha}$$

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